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A novel method for removing geological precipitates from animal fossils

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Introduction

There are in use different methods to remove the surrounding material from a fossil (Robinson, 1965; Stucker et al., 1965; Wagsraffe, Fidler, 1968; Rixon, 1976; Croucher, Wooley, 1982; Hodkinson, 1995; Lindsay, 1995; Wilson, 1995). There are mechanical as well as chemical methods, and the use of some physicochemical processes is not unknown. In the first category of methods the use of chisel and hammer, vibrating or rotating equipment is very extensive. The use of microsandblasting as well as the application of ultrasonic equipment find also a place in the sometimes very difficult task to obtain without damage a fossil by removing or destroying the surrounding material.

On the other hand, a number of acids or sequestering agents have been used for the same purpose (Croucher, Wooley, 1982; Hodkinson, 1995; Lindsay, 1995; Wilson, 1995; Toombs, 1948; Rixon, 1949). Other ideas such as the use of high or low temperature, the accumulation of soluble salts etc. have also been applied in some cases (Rixon, 1976; Arnold, 1976; Rossi, Tucci, 1991).

When now a conservator of stone in building faces the problem of removing the sediments from a fossil he has to apply his knowledge much in the same way. It is well known to the conservators of stone that there are different physicochemical processes that could deteriorate the stone material (Amoroso, Fassina, 1983; Torraca, 1982; Stambolov, Van Asperen, 1984; Lambropoulos, 1993; Lazzarini, Laurenzi Tabasso, 1986; Arnold, 1976; Delgado Rodrigues, 1976; Pelizzer, Sabatini, 1975; Skoulikidis, Charalambous, 1981; Price, 1975). The same processes can be applied artificially to the surrounding material of a fossil to disintegrate it leaving the fossil itself intact.

Another problem the conservator of fosssils has to cope with is their friability. In some cases the removal of surrounding material is impossible because at the same time the fossil disintegrates as well. The necessity of consolidation of the fossil prior to its removal is obvious.

Different processes of consolidating stone materials either in monuments or in artifacts involve the precipitation of solid mater in between the pores of friable stones (Hempel, 1976; Furlan, Pancella, 1981; Rossi, Tucci, 1984; Skoulikidis et al., 1991; Skoulikidis et al., 1996; Skoulikidis et al., 1995; Oddy, 1977; De Witle et al., 1977; Price et al., 1988; Rossi, Tucci, 1991; Saleh, 1992; Tiano, 1995).

Both these principles were studied in our research involving an easier and safe removal of fossil animal bones found in three different palaeontological sites in Greece (Fig. 1).

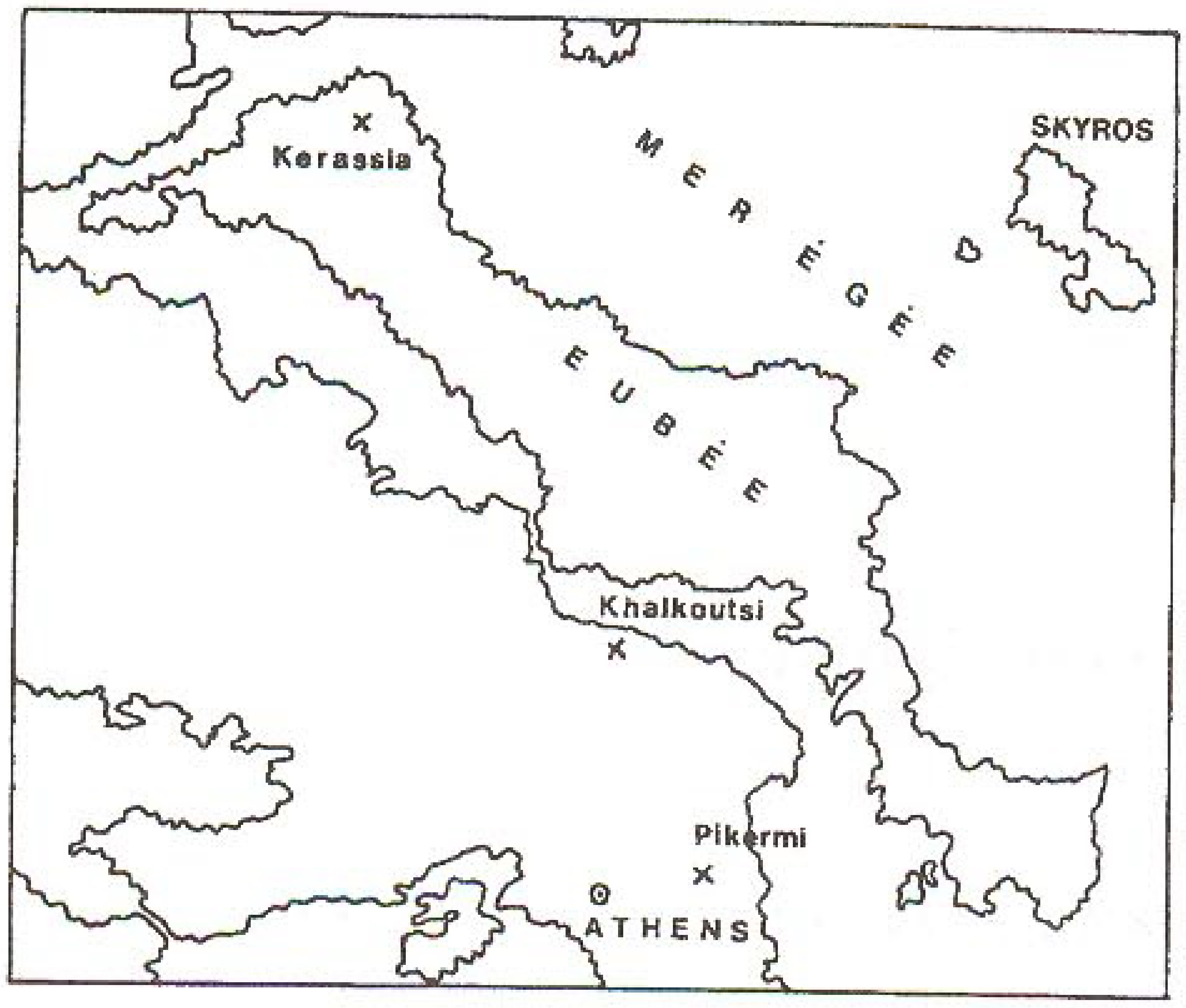

Fig. 1. The three sites studied

Procedure

Before applying a destructive method in palaeontological specimens we have to know the mineralogical composition of the sediments as well as that of the fossil. In the three cases we have considered in our research the mineralogical composition of the surrounding sediments is very close. We are talking for aluminosilicate precipitates with a considerable amount of quartz and a smaller percentage of calcite. (Table 1). In contrast to the composition of the geological precipitates the composition of the fossils is completely. They consist mainly of apatite and calcite.

It is well known to the conservators of stone that a stone containing an appreciable amount of aluminosilicates is very sensitive to the action of water. The swelling clays expand while both swelling and non-swelling clays hydrolyse. Another action may be an ion exchange process that could also to the destruction of the stone.

In our case we used intentionally this destructive action of water to disintegrate the aluninosilicate minerals of the surrounding material.

According to the state of preservation of the fossils we have to modify our work in order to cover all three cases. As we referred above the composition of the geological precipitates in the three cases is very similar. The great difference however is in the state of preservation of the fossils in the three cases.

Table 1

Mineral	Site		
	Pikermi	*Khalkoutsi*	*Kerassia*
Feldsparts	6-8 %	6-7 %	4-6 %
Muscovite	7-9 %	7-8 %	8-10 %
Biotite	4-5 %	2-3 %	4-5 %
Chlorite	9-10 %	13-15 %	12-14 %
Illite	8-12 %	6-7 %	7-9 %
Montmorillonite	12-15 %	17-19 %	15-17 %
Quartz	16-18 %	14-17 %	14-16 %
Calcite	11-13 %	10-12 %	10-12 %

The fossils from Pikermi are in a very good state of preservation. The bones are coherent and strong and very few minor cracks appear in places. The fossils from Khalkoutsi are in a moderate state of preservation. They are not very strong and sometimes at the edges are friable. Those from Kerassia are in a very bad state of preservation. The fossils are very friable so that they cannot stand the application of any force even a minor one. The danger of breaking into small pieces is very high.

In the case of Pikermi the application of water to the block containing the fossils is immediate. The whole block can be soaked in water. To facilitate the process of impregnation a vacuum can be applied (Plate I, Figs 1, 2, 3). According to the size of the block different devices to apply vacuum can be invented (Hempel, 1976).

In the case of Khalkoutsi some precautions have to be taken during the impregnation process in order to avoid the disintegration of the fossils at the same time as the disintegration of the surrounding material occurs. Such precautions are to hold firmly together the sediment with the fossils allowing at the same time the water to impregnate the whole block. Using medical bandages to hold firmly the material of the block is an easy solution. This procedure allows also repeated impregnations with drying of the block in between impregnations in order to make use of the thixotropic effect of the different clay materials which take part in the composition of the sediments.

When the process of disintegration of the surrounding material reaches the stage that will allow its easy removal then the bandages are removed and we proceed to the careful revealing of the fossils. During this process it may be necessary to consolidate the bones as they appear using a synthetic resin solution or emulsion. In wet cases an emulsion is more suitable while in dry cases a solution is more convenient (Plate II, Figs 1, 2, 3)

The most difficult case proved to be that of Kerassis where the fossils are very friable and brittle in contrast to the surrounding material which is much stronger. In this case any attempt of soaking the block in water result to the disintegration of the fossils and the use of organic consolidants did not solve the problem. A stronger consolidation is needed and we turned to the inorganic materials.

A process with which the conservators of stone are familiar is the precipitation of inorganic materials in the pores of friable and brittle stones (Skoulikidis et al., 1991; Skoulikidis et al., 1996; Skoulikidis et al., 1995; Price et al., 1988; Rossi, Tucci, 1991; Tiano, 1995). Materials close to the composition of the stones are usually used, i.e. calcium carbonate for calcareous stones and silica for silicates.

In our case taking in consideration the composition of the fossils the precipitation of either calcium carbonate or calcium phosphate could be attempted. We decided instead to use another insoluble calcium salt, calcium oxalate, for this consolidation. The criteria for this decision were that:

a) we avoid any confusion between the new carbonate or phosphate material and those of the original composition of the fossil.

b) The conditions in which the fossils will remain after conservation are unlikely to produce any appreciable change due to the inhomogeneity of materials.

In the case of stone consolidation however the outdoor conditions are much more harder and any inhomogeneity introduced by the conservation process could be dangerous.

The process applied to the blocks from Kerassia is analysed to the following stages: (Table III, Figs 1, 2, 3).

a. Binding the block firmly with medical bandages.

b. Impregnation with a 2,5 % solution of sodium oxalate.

c. Drying in the oven.

d. Impregnation with a 3,3 % solution of calcium nitrate (Calcium nitrate was chosen from other soluble calcium salts because is less deliquescent).

e. Drying in the oven.

f. Removing the bandages and the most part of the surrounding material, which has become brittle, while the fossils are strongly consolidated.

g. Desalination.

This later stage is necessary to avoid any damage to the fossil due to the accumulation of soluble salts. This desalination process is done in changes of deionized water. The fossils are very strong and they can stand a repeated soaking in deionized water while the precipitates still adhering to the fossils at the beginning of desalination process they desintegrate before its completion. The desalination progress was secured by monitoring the conductivity of the bath. When we were near to that of deionized water it was considered as complete.

Conclusions

The application of physicochemical methods in removing sediments from animal fossils proved most effective. The principle used in our research was the disintegration of aluminosilicates by the action of water since the main ingredient of the precipitates, in our case was this type of minerals. Other processes of disintegration or degratation of stone can also be used according to the composition of the precipitates.

The application of a particular method in conservation may pose different problems related to each case. In our work we to deal with the problem of friability of the fossils. In such a case a consolidation of the fossil is necessary prior to removing the surrounding material. This was achieved by precipitating the insoluble calcium oxalate produced by the reaction of sodium oxalate and calcium nitrate. The reaction product was formed in the whole mass of the block, but only the part precipitated within the pores of the friable fossil remained in place. The crystals of calcium oxalate were removed during disintegration of the aluminosilicates or washed away during the process of desalination.

The process of consolidation may also pose problems either practical or ethical. For example shall we use an organic or an inorganic consolidant? In the case of inorganic material, do we have to use the material as these of the fossil or a different material? To what extent an inhomogeneity is acceptable? Will the consolidating material work together with those of the fossil?

In the field of stone conservation when we are referring to monuments or statues the ethical problems are more or less solved by international agreements, although in practice some deviations are by necessity acceptable. In the conservation of fossils however these problems have not been discussed extensively and in the bibliography we find methods with which a conservator of antiquities would not agree.

In our research in the consolidation process we could have used the precipitation of calcium carbonate or calcium phosphate since these ingredients from the great percentage of the fossil. Instead we used calcium oxalate. A future research we have in mind will compare the results obtained by using different consolidating materials.

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PLATE I

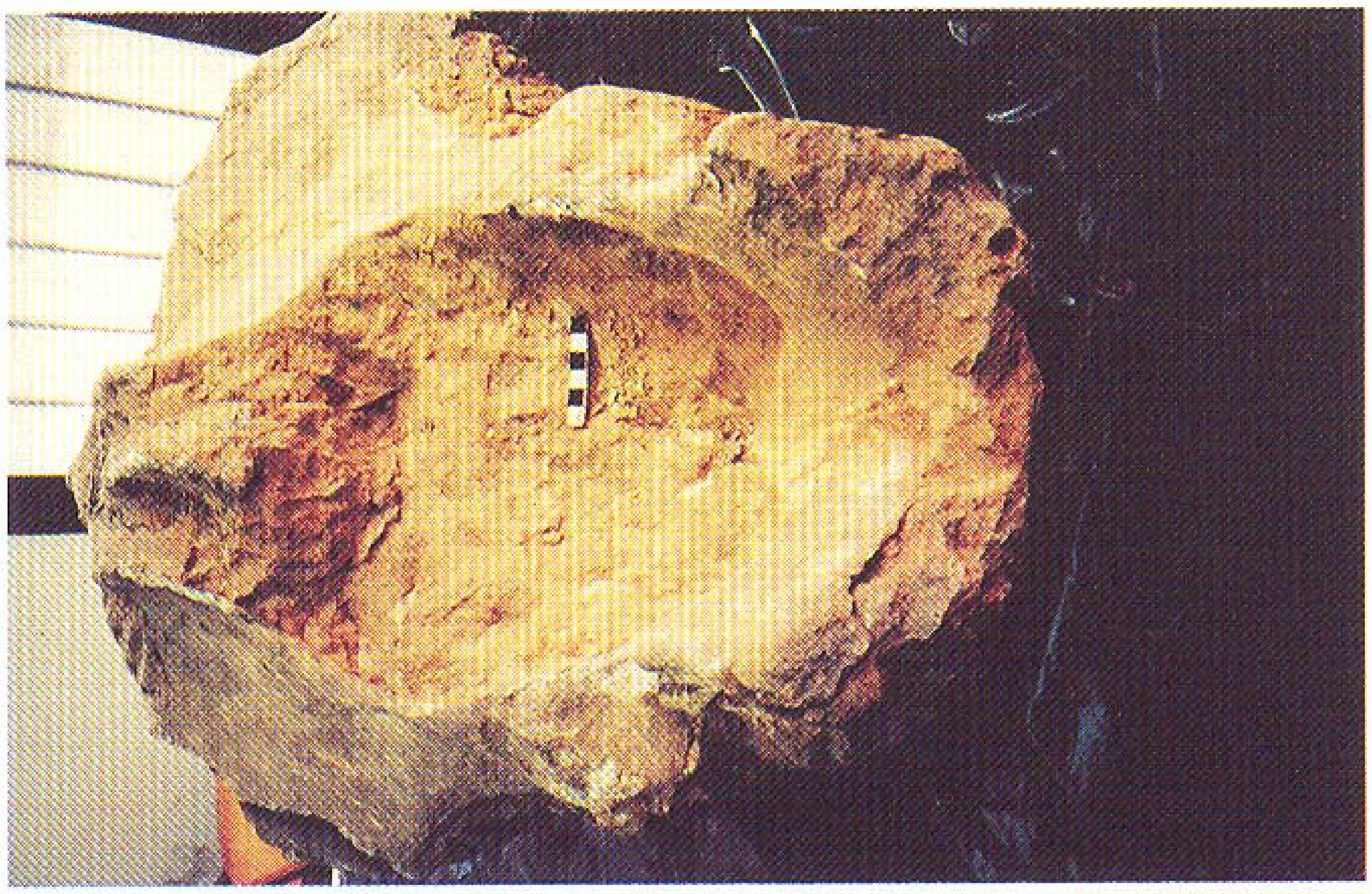
1. The block from Pikermi
2. Soaking in water
3. After the complete removal of the sediment

PLATE II

1. The block from Khalkoutsi
2. Soaking in water
3 The Fossils after the complete removal of the sediment

PLATE III

1. The block from Kerassia
2. After consolidation with inorganic salts
3. After the removal of the sediment a vertebra appeared



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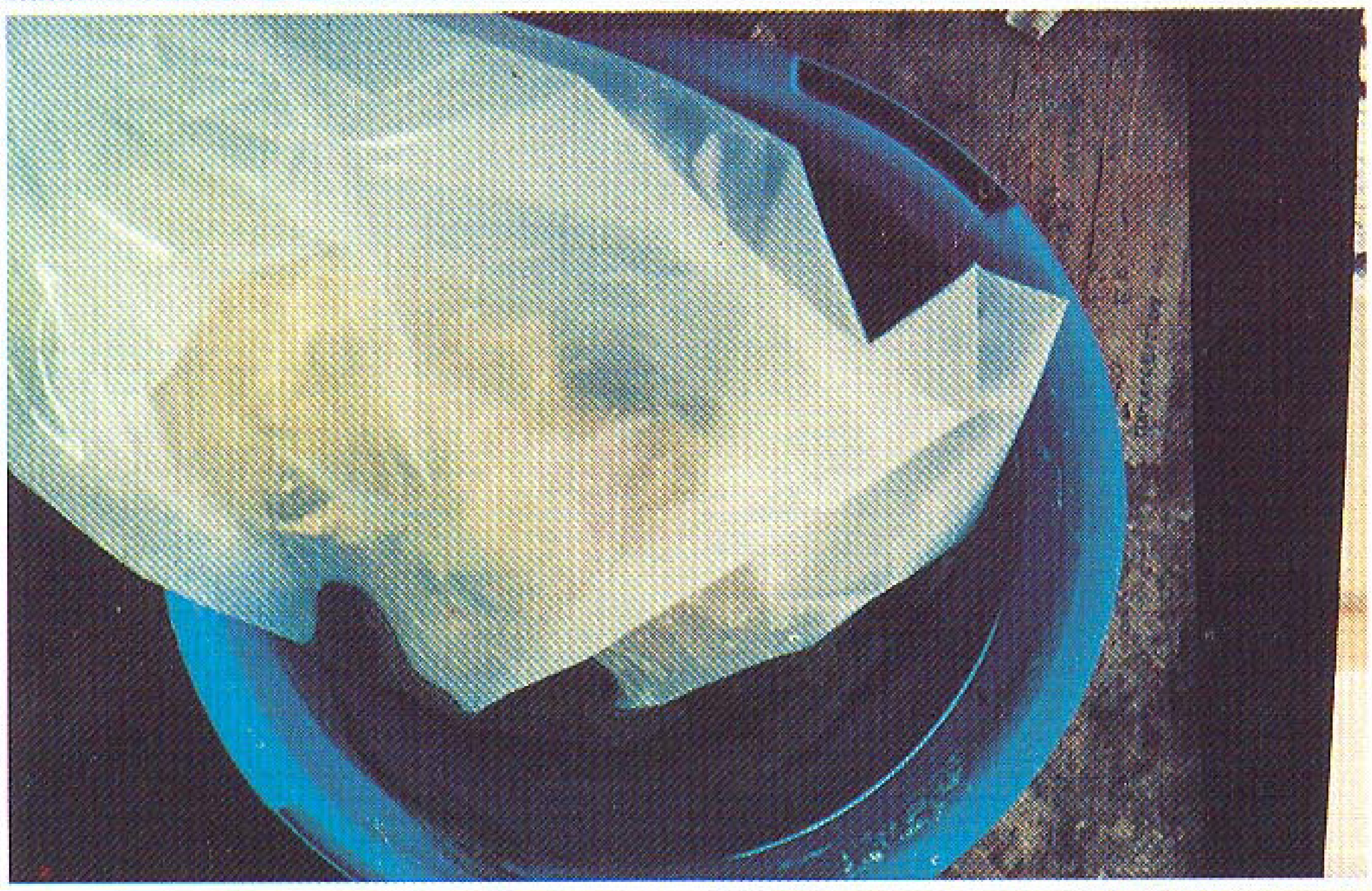

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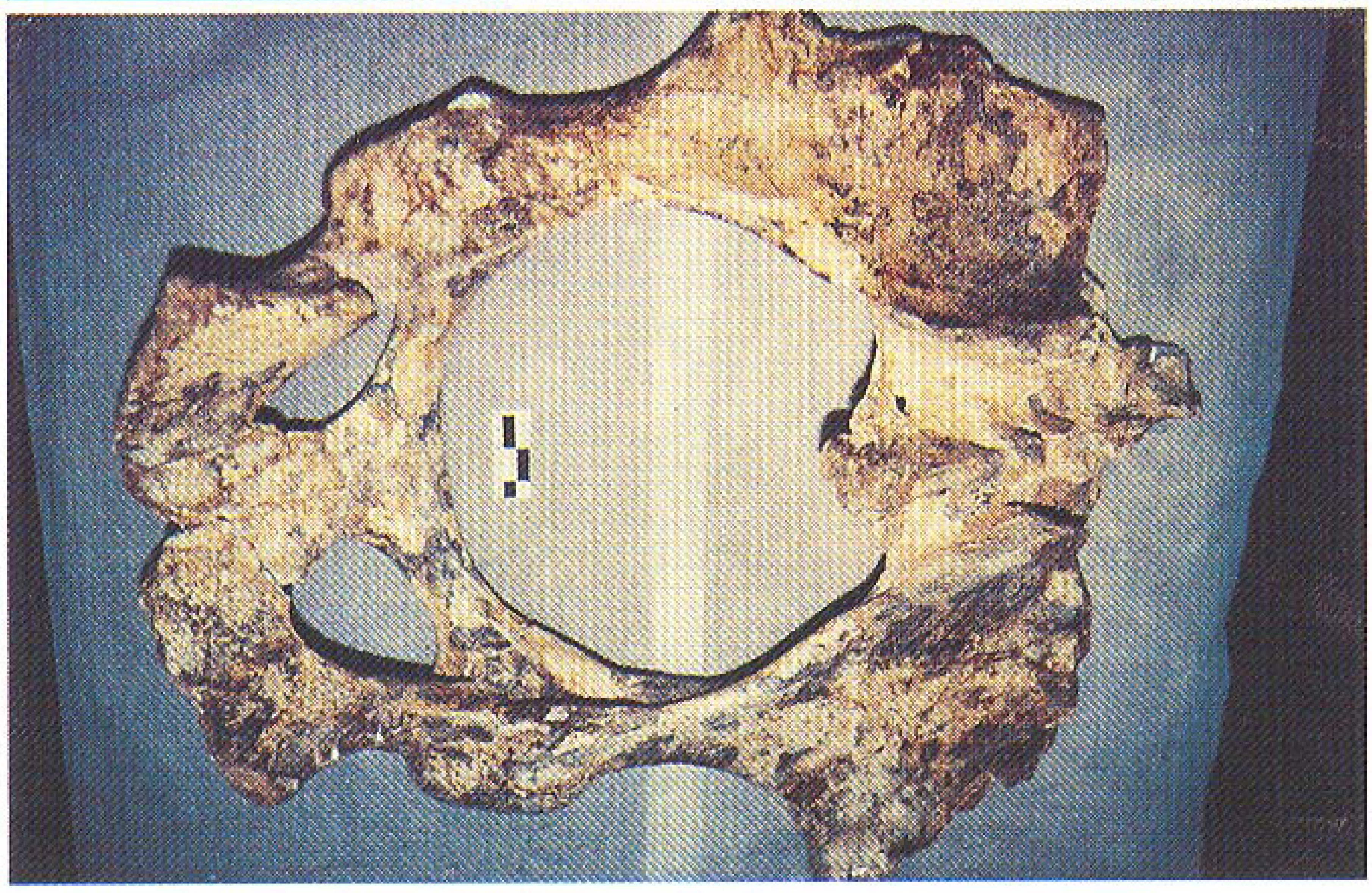

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PLATE II

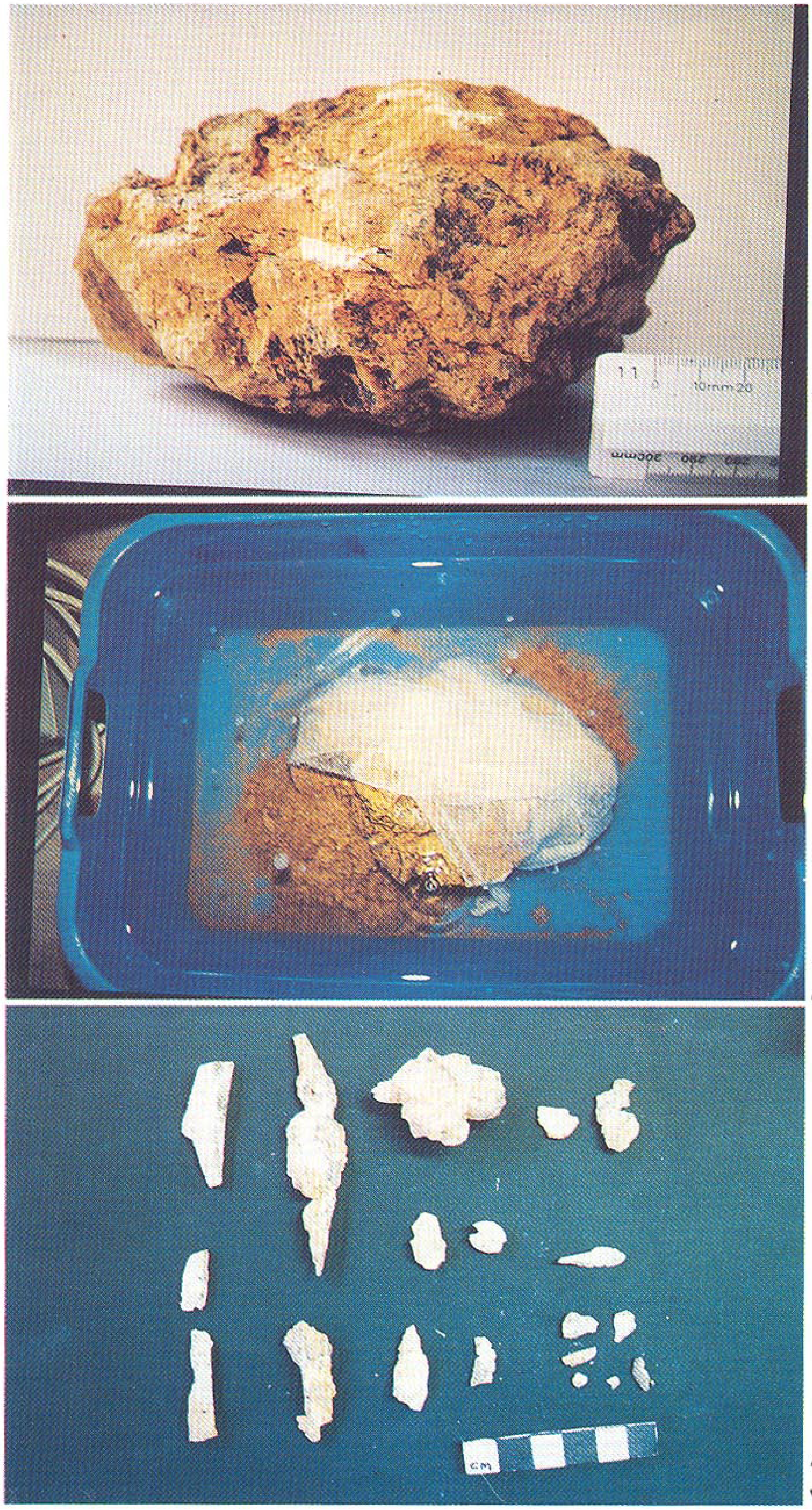

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PLATE III

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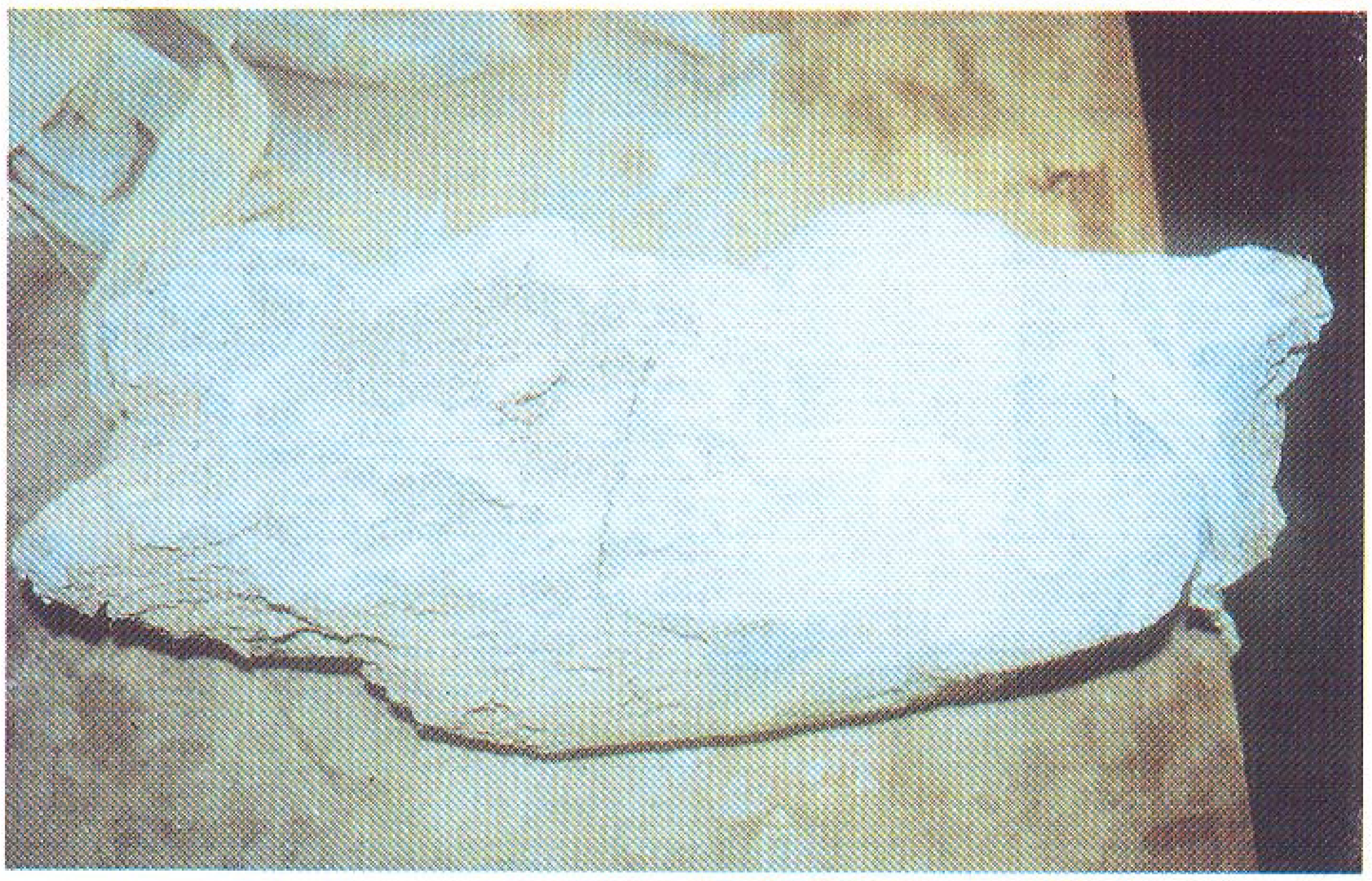

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